10/539741
Rec'd PCT/PTO 20 JUN 2005
PCT/CA 03 01999
30 JANUARY 2004 30-01-04

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Specification and Drawings, as originally filed, with Application for Patent Serial No: **2,414,908,** on December 20, 2002, by **Dr. DEREK TURNER**, for "Dental Handpiece".

PRIORITY DOCUMENT
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L. Réginbal

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(CIPO 68)
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ABSTRACT

A dental handpiece is disclosed with a turbine construction wherein a radial airflow into the turbine about the whole circumference of the turbine is created, which generates additional torque and simultaneously centralizes the turbine wheel. The turbine is supported by a pair of axially spaced air bearings which are controlled in such a way that the air bearings are floated before drive air is supplied to the turbine and after drive air to the turbine has been shut off. This ensures that the air bearings are always operational irrespective of the operational state of the turbine. The handpiece has an improved ergonomic shape, especially the shape and configuration of the front or head portion, which provides additional tooth clearance and a better field of view. An angled swivel connection to the umbilical cord is provided to reduce physical strain on the dentist's wrist. A lock and key type torque connection between the dental burr and chuck is provided which accommodates both conventional burrs and the burr of the lock and key arrangement. An auto stop arrangement for the turbine is disclosed which prevents a vacuum build-up during run-down of the turbine. The specific construction of the auto stop valve in accordance with the invention closes both the drive and exhaust air conduits.

DENTAL HANDPIECE

FIELD OF THE INVENTION

This present invention relates to medical and dental equipment and particularly to turbine driven medical or dental handpieces.

BACKGROUND OF THE INVENTION

Turbine driven handpieces are widely used in dental offices and medical labs around the world. Most handpieces include a handle portion, a connector at one end of the handle portion and a head portion at the other end of the handle portion. The connector provides a connection of the handpiece to various air, water, light and power supply conduits, generally combined in a so called umbilical cord. The head portion houses a tool rotating assembly, generally composed of a tool mount or chuck, and a turbine, rotatably mounted in the head for driving the chuck.

Various different types of turbine arrangements are in use, all of which include a turbine housing, a supply of pressurized air into the housing for driving the turbine and a set of bearings for rotatably supporting the turbine in the housing and the head. Since conventional dental handpieces are constructed to rotate the dental drill or burr at speeds of up to 500,000 rpm, the bearings are subject to large stress. This is exaggerated by the bearings having to additionally support the chuck and tool against the lateral forces applied to the tool during operation and the radial force on the turbine generated by the tangentially impinging drive air, which is the case in most handpiece designs.

In existing handpieces, mostly ball bearings are used, which generally have a maximum service life of 3 months and must be lubricated each time they are subjected to sterilization conditions. Although ceramic bearings have come on the market recently which are more robust and are maintenance free in that they do not need to be lubricated after each sterilization, their service life is still not satisfactory.

US Patent US 3,906,635 is directed to a dental handpiece with air bearings. In that handpiece, a central spindle supporting the turbine wheel and having an axial, burr receiving bore is supported in the head portion of the handpiece by a pair of bearing sleeves which are closely spaced from the spindle, forming a very narrow air passage or air gap therebetween. The bearing sleeves are respectively mounted in a pressure chamber to which pressurized drive air is supplied. The bearing sleeves each include a number of air passages allowing pressurized air to pass from the pressure chamber into the air gap between the spindle and the bearing sleeve. The drive air is supplied simultaneously to the turbine and the air bearings. The pressurized drive air supporting the spindle enters into the bearing chambers, passes through the bearing sleeves and into the air passages, and from there gets exhausted to ambient or into the turbine chamber. It is easily apparent that operating the air bearings and the turbine with the same drive air causes a major disadvantage. At shut down of the drive air, the turbine still rotates while the air pressure is no longer sufficient to fully support the spindle in the bearing sleeves. This can result in serious damage to the bearing, which in turn limits the service life of the turbine drive unit. Although the cylindrical air cushions may properly support the spindle in radial direction, very little support in axial direction is provided. Axial thrust washers are provided in the prior art construction, which support the spindle in axial direction. Although annular air cushions are provided around the thrust washers, the overall surface of these air cushions appears to be quite small considering the potentially large axial thrust force applied to the spindle upon contact of the burr with a tooth. Furthermore, the sharp angle at the transition from the cylindrical cushion to the annular cushion impedes the flow of cushioning air. Thus, an improved bearing design is desired.

Many different air turbine designs and constructions exist, but in common turbine designs drive air is tangentially supplied to the turbine towards the circumference of the turbine wheel which is generally a paddle wheel or similar type turbine wheel. The tangential air supply generates a lateral force on the bearings, which increases stress and wear. Furthermore, the torque generation of the turbine is low due to the localized drive air supply

and parasitic airflow (drag) is high when the drive air is supplied tangentially at the circumference of the turbine.

Numerous air turbine designs are known in the prior art, wherein a paddle wheel type turbine rotor is driven by drive air impacting onto the turbine vanes at the outer ends thereof and in a direction tangential to the turbine circumference. Representative of the prior art designs are US Patent US 6,120,291 and US Patent Application US 2001/0002975. Although US Patent 4,470,813 discloses an air driven turbine arrangement wherein the drive air is redirected radially before impact onto the turbine wheel, the drive air is still directed onto the turbine vanes in one location and in a generally tangential direction. Thus, a need exists for an improved turbine construction generating higher torque output and less bearing stress.

Prior art chucks of dental handpieces are almost exclusively designed to hold the dental burr by way of friction fit only. Examples of such constructions are found in US Patents US 4,595,363, US 5,549,474, and US 5,275,558. Only low torque transmission is possible between the chuck and the burr in such constructions, higher torque leading to slippage. In US Patent 6,065,966, a spring loaded pin is used for engaging a recess in a dental tool. However, the use of this arrangement in an air turbine handpiece is not disclosed. In fact, the disclosed arrangement could not be used to hold a dental burr, since the engagement between the pin and the chuck is designed for a non-rotating tool and does not easily lend itself to being used with a rotating tool.

A lock and key type connection is known from US Patent US 4,370,132 which teaches the use of a burr with a shank having a flattened end portion at the upper shank end. A dog rigidly connected with the burr receiving sleeve is provided for engagement with the flattened end of the burr shank. The burr cannot be fully inserted into the chuck until the burr end fits into the dog, so that the burr must be turned relative to the chuck until these interlocking portions align. It is a disadvantage of this prior art arrangement that the burr must be rotated in the chuck until the lock and key structures fit together. Since the chuck also provides a friction fit with the burr, rotating the almost completely inserted burr within the chuck would necessitate some kind of mechanism which keeps the chuck from rotating in the head portion,

or the burr must be repeatedly removed and reinserted in a slightly different angular position. Locating the interlocking mechanism deep in the head portion of the handpiece makes it impossible for the user to visually pre-align the lock and key structure prior to insertion of the burr. Thus, insertion of the burr is an exercise of trial and error. It is also disadvantageous that the dog used in the prior art arrangement protrudes permanently into the burr receiving bore of the chuck so that the handpiece cannot be used with standard burrs without a flattened top end. Thus, an improved chuck and burr interlocking arrangement is desired which more easily used and allows the use of standard burrs.

Dental handpiece air turbines are normally shut down by simply stopping the supply of pressurized drive air. However, since the turbine is rotating at high speed, it takes some time to gradually slow down and come to a stop. This is undesirable, since for safety reasons, the dentist must wait until the turbine has fully stopped before removing the handpiece from a patient's mouth. Furtermore, during this so called rundown period, the continued rotation of the turbine generates a vacuum in the turbine chamber which may lead to contamination being sucked into the chamber.

US Patent US 5,507,642 discloses a discharge air shut-off arrangement for a dental handpiece turbine unit, which automatically prevents the flow of discharge air through the lower bearing during rundown of the turbine in order to prevent the generation of a vacuum. This is achieved by using a flexible Belleville washer which is held in a flat configuration by the drive air and automatically curves upward when the drive air is shut off, thereby closing off the air discharge passage. US Patent US 5,782,634 discloses an auto-stop arrangement which includes a valve in the exhaust air conduit which is operated by the drive air pressure and closes the exhaust air conduit when the drive air pressure falls below a certain level. However, the valve arrangements of these two patents shut off only the exhaust air conduit, not the drive air and chip air/water conduits. Thus, contamination may still occur. Consequently, a mechanism is desired which provides for a reliable and quick stopping of the turbine and prevents contamination as much as possible.

Dental turbine handpieces generally include either a straight neck or a bent neck the latter intended to facilitate access to the back of a patient's teeth. However, the tooth clearance achievable with such a construction is limited by the length of the burr. For some situations, a better tooth clearance is desired. Furthermore, the treatment field is usually partially obstructed during use by the head portion and the neck. US Patents 1,984,663 and 4,820,154 respectively disclose a dental handpiece with an adjustable neck angle and a dental instrument (scaler) with a neck portion including two bends. Thus, a handpiece neck portion design is desired which provides additional tooth clearance and improved visibility of the field of treatment.

As mentioned, fluids and power are supplied to dental handpieces by way of an umbilical cord normally removably connected thereto at a rear end. The connection is usually achieved by a straight swivel connection. However, this places a fairly high twisting strain on the wrist of the user, since the straight swivel connection combined with the inherent rigidity of the umbilical cord acts as a sort of lever which exaggerates the actual downward force created by the weight of the cord. This problem has plagued dentists for years with no solution for dental handpieces being available. Various swivel connectors are known in the art for releasable connection of a dental handpiece to the umbilical cord including the working fluid supply and fiberoptic conduits. Examples of swivel connectors are shown in US Patents US 5,057,015, US 6,033,220 and US 6,319,003. However, all of these connectors provide only a straight connection between the umbilical cord and the handpiece. Thus, a need exists for a connector which reduces wrist strain.

SUMMARY OF THE INVENTION

It is an object of the present invention to obviate or mitigate at least one disadvantage of existing handpiece designs.

In a first aspect, the present invention provides a turbine design and method of operation, wherein drive air is evenly distributed in an annular chamber before it is impacted

in a radial direction onto the turbine wheel. The results are higher torque and self-centering of the turbine, the latter being particularly important for longevity of the bearings used.

In a further embodiment, there is provided air bearings for the turbine and the chuck which respectively include a bearing cup of substantially semi-spherical shape and a bearing body of complementary shape for fitting into the bearing cup, the bearing body being shaped and constructed to fit into the bearing cup with an intermediate air gap for bearing air.

In another aspect, the present invention provides a solution to the problem of slippage of the burr in the chuck in high torque situations. The burr/chuck combination of the invention employs a lock and key interengagement structure. The burr has a shaft section (locking shaft) of non-circular shape and the chuck or the bearing has a seat of complementary shape. The chuck is preferably designed to provide friction fit for standard burrs with circular shaft and lock and key fit for the burr in accordance with the invention having the locking shaft.

In yet a further preferred embodiment in accordance with the invention, a burr locking structure is provided which includes a chuck having a central bore for receiving standard burrs, and a socket portion at an outer end of the bore for receiving a lock portion on a burr in accordance with the invention. The socket and lock portion are non-circular in cross-section and of complementary shape to prevent rotation of the lock portion in the socket. This prevents rotation of the chuck relative to the burr and allows for reliable torque transfer. The chuck is preferably constructed to allow visual alignment of the complementary shapes of the socket and lock portion during insertion of the burr.

The preferred embodiment of the handpiece in accordance with the invention now addresses the problem of excessive wrist strain by providing an angled swivel connector, which brings the point of attack of the downward force exerted by the weight of the umbilical cord close to the wrist so that the twisting strain is significantly reduced.

Other aspects and features of the present invention will become apparent to those ordinarily skilled in the art upon review of the following description of specific embodiments of the invention in conjunction with the accompanying figures.

BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the present invention will now be described, by way of example only, with reference to the attached Figures, wherein:

Figs. 1 and 2 illustrate the shape and design of the turbine and bearing unit of the handpiece in accordance with the invention;

Fig. 3 shows various cross-sections of the head portion of a preferred embodiment of the handpiece in accordance with the invention and illustrating the chuck and burr interlocking structure;

Fig. 4 shows perspective, partially cut-away and cross-sectional views of the handle (stem) and neck portion quick coupling in accordance with the invention;

Fig. 5 illustrates the auto-shutoff mechanism in accordance with a preferred embodiment of the invention;

Fig. 6 illustrates the auto-shutoff mechanism of Fig. 5 in a different operational state;

Fig. 7 is a perspective view of a dental handpiece in accordance with the present invention;

Figs. 8 and 9 illustrate the ergonomics of a handpiece in accordance with the present invention;

Fig. 10 illustrates the lighting system of a preferred handpiece in accordance with the present invention; and

Fig. 11 is an exploded view of the preferred handpiece of the present invention.

DETAILED DESCRIPTION

Generally, the present invention provides a medical or dental handpiece and a method of operating and controlling the handpiece. Although for the sake of simplicity reference is made in the following to a dental handpiece, all structural and functional features of the invention are equally applicable to medical handpieces and other handpieces for supporting high speed rotating tools.

As is apparent from FIG 7, a dental handpiece 10 in accordance with the invention includes a stem/handle portion 11, a plug-in connection 12 for linkage with an umbilical cord 13 (see FIG 5), and a neck/head portion 16 with a drive head14 for rotatably supporting and driving a tool 15. The inventor has identified several construction features of currently sold dental handpieces, which are in need of improvement. The turbine and bearing unit, the burr (drill) and chuck interengagement, and the overall ergonomics, construction and connectivity of the handpiece.

Air Bearings

The preferred embodiment of the handpiece 10 of the invention includes an improved head portion 14 with a drive unit 20 consisting of pair of spaced apart maintenance free air bearings 30 (see FIGs 1 and 2) a chuck 40 and an air turbine 50 housed in a turbine chamber 60. Each bearing 30 consists of a bearing cup 31 and a bearing body 32 of complementary shape and received in the cup 31. The bearing body 32 is sized to fit into the cup 31 with sufficient play so that an air gap 33 (bearing gap) of even thickness is created between the bearing parts. During use, compressed air is blown into the bearing gap 33 to support the bearing body 32 in the cup 31 at an even spacing therefrom. The supply of drive air, bearing air and chip/cooling fluid is controlled such that separate bearing air is supplied to the handpiece 10 irrespective of whether the drive unit 20 is rotating. This means the bearing 30 is resting on an air cushion and ready for operation at all times when the handpiece 10 is lifted off its stand (not shown). This will ensure that the bearing 30 is always active before the turbine 50 is rotated in order to prevent damage to the bearing and to significantly reduce wear.

Radial Air Flow Turbine

The drive unit 20 includes the air turbine 50 and the dental tool (burr) receiving chuck 40 which is supported in the handpiece 10 by the bearings 30. Air turbine 50 is connected with the bearing body 32 of the lower bearing 30 for torque transfer. It will be readily apparent by the person skilled in the art that this connection can be achieved in a multitude of ways, all of which are usable within the context of the present invention as long as the

connection is co-axial and prevents rotation of the turbine relative to the bearing body. Examples of applicable types of connection are an adhesive connection, an interlocking connection (lock and key type) between the two parts, a press-fitting of the bearing body 32 and the turbine wheel 50, etc. In the preferred embodiment illustrated in FIGs.2 and 3 the bearing body 32 includes an axially protruding connection flange 34 which is received in an axial bore 53 in the turbine wheel 50. The flange 34 and bore 53 include respectively complementary axially extending radial protrusions (not illustrated) which allow axial insertion of the flange 34 into the bore 53, while preventing rotation of the flange in the recess. The improved drive unit of the invention includes a radial airflow turbine in contrast to the paddle wheel type turbine commonly known. The radial flow turbine design requires that the drive air be supplied to the turbine radially inwardly rather than tangentially. This is achieved in the preferred embodiment in accordance with the invention with a drive unit 20 including an annular air supply chamber 70 extending concentrical about the axis of rotation and radially inwardly connected to the turbine chamber 60 through a Venturi passage 72. The venturi passage 72 extends continuously about the axis of rotation and provides a restriction or nozzle for speeding up the drive air supplied into the chamber 70 through drive air supply conduit 75. The drive air is evenly distributed in the annular air supply chamber 70 and redirected radially inwardly towards the axis of the turbine wheel 50 by a plurality of stationary radial air vanes 74 positioned in the Venturi passage 72. Directing the drive air radially inwardly significantly reduces parasitic airflow (drag) compared to paddle wheel type turbines in which the drive air is supplied tangentially at the circumference of the turbine 50. Radial drive air supply also generates additional torque due to the extended engagement time of the air with the turbine 50. The torque output of the turbine 50 is also improved by using the annular Venturi air supply nozzle 72, since it causes the drive air to speed up immediately prior to impact with the turbine 50. The Venturi passage 72 also creates a back pressure in the annular chamber 70 and thereby ensures an even drive air pressure in the supply chamber 70 and therefore an even drive air pressure about the whole circumference of the turbine 50. Supplying the drive air radially and evenly about the circumference of the turbine also

provides an automatic centering of the turbine 50, which greatly reduces radial stress on the bearings 30, especially the top bearing of the turbine 50.

Chuck and Burr Lock

As shown in FIG 3, the preferred embodiment of the handpiece 10 of the invention incorporates an interengagement structure for preventing slipping of the burr 80, within the head 14. The interengagement structure includes the chuck 40, the bearing body 32 and a locking socket 43 integrated in the bearing body 32 of the lower bearing. The burr 80 is received in an axial passage through the bearing body 32 and chuck 40. The burr 80 and chuck 40 are designed so that the burr is held in the chuck by friction. This is achieved by forcing the chuck 40 against the burr 80. Chuck 40 includes a ramped shoulder 42 extending about the outer circumference of the chuck 40 at a bottom end 43 thereof. The turbine wheel 50 includes a correspondingly ramped seat 52 in the bore 53. Chuck 40 is axially movable in the bore 53 between a locking position wherein the shoulder 42 engages seat 52 and the bottom end 42 of the chuck 40 is forced radially inwardly, and a release position wherein the shoulder 42 is axially spaced from the seat 52 and a burr 80 is freely insertable or removable from the chuck 40. Of course, chuck 40 is made of a material which provides the requisite amount of flexibility to allow for sufficient deformation of the chuck 40 to frictionally grip an inserted burr 80. Chuck 40 is normally urged into the locking position by a Belleville washer 44 extending about the chuck 40 below a radial top flange 45 and forcing the top flange 45 away from the turbine wheel 50. A flexible push button actuator 21 allows the operator to move the chuck 40 into the release position by way of an intermediate actuator ball 22 received in a complementary seat 46 in the top end 47 of the chuck 40. Depressing the push button 21 forces ball 22 and chuck 40 downward until shoulder 42 no longer engages seat 52. This type of frictional burr locking and chuck release arrangement is standard in the art and need not be further described in detail.

Rotation of the burr 80 relative to the chuck 40 and turbine 50 is prevented by an interlocking structure including lock and key type portions on the bearing body 32 and the burr 80 respectively. The burr 80 has a shaft 81 of generally constant cross-section for fitting

insertion into the burr receiving axial passage of the bearing body 32 and the chuck 40. The shaft includes an enlarged locking boss 82 of non-circular cross-section. The bearing body 32 of the lower bearing 30 includes a locking socket 35 complementary in shape to the locking boss 82 of the shaft 81. The socket 35 fittingly receives the locking boss 82 so that rotation of the burr 80 relative to the bearing body 32 and thereby the turbine 50 is thereby reliably prevented. The axial position of the boss 82 on the shaft is selected such that the boss 82 non-rotatably engages the socket 35 when the burr 80 is fully inserted into the chuck 40. Thus, the problem of burr slippage at high torque commonly observed in prior art handpiece constructions is thereby overcome. The boss 82 and socket 35 can have any cross-sectional shape other than circular, as long as their respective shapes reliably prevent rotation of the burr 80 relative to the bearing body 32 when the burr 80 is fully inserted into chuck 40. The socket 35 is preferably positioned on the bearing body 32 to be easily visible to the user. This allows the user to visually align the shape of the boss 82 with the shape of the socket 52, thereby facilitating insertion of the burr 80.

Head Portion Quick Connect

Conventional handpieces include a neck/head portion which houses the drive unit and a stem/handle portion for manipulation by the dentist, which stem portion includes at the rear end a coupling for the umbilical cord housing the air and water supply lines. The neck and stem portions are generally combined in a single part. This is disadvantageous since the coupling will be subjected to harsh sterilization conditions when the handpiece is sterilized, which often leads to premature failure of the coupling components (such as O-rings). The preferred embodiment of the handpiece of the present invention as illustrated in partially cut-away view in FIG 4 is constructed in two parts so that the neck/head portion 14 can be separated from the handle/stem portion 11 and separately sterilized. According to existing health standards, the handle portion need not necessarily be heat sterilized. Thus, with the handpiece construction of the present invention, the head portion can be heat sterilized and the handle portion can be sterilized by another method less detrimental to the sensitive components of the umbilical cord connection 12 (see FIG 7). A quick connect coupling is

provided between the two parts which is non-rotatable and includes a connector cap 90 inserted into the handle sleeve 17 and a complementary connector stem 91 integral with the neck portion 14. Cap 90 and stem 91 are of complementary shape so that the stem 91 non-rotatably fits into the cap. The connection is constructed as a snap-fit connection by way of a a pair of spring loaded pins or balls 93 in the connector cap 90 which respectively engage one of a pair of snap-in recess 94 in the stem 91.

The quick connection is further provided with an automatic shut-off valve for the turbine drive air, the turbine exhaust air and the chip water/air. This provides for instant on/off of the turbine and chip water/air. That is a very important advantage, since with current handpiece designs the dentist must wait until the burr has slowed to a stop before removing the burr from the patient's mouth in order to avoid injury to the patient's tongue or lips. The automatic shut-off valve includes a valve sleeve 61 operated by the turbine drive air (see FIGs. 5,6 and 11). The valve sleeve 61 is usually forced by a spring 66 into the closed position as shown in FIG. 6, wherein it closes the drive air supply conduit 62, the chip water/air supply conduit 63 and the turbine air exhaust conduit 64. Thus, in the closed position of the valve sleeve 61, no air can be supplied to and or exhausted from the turbine chamber 60, which prevents the build up of a vacuum in the turbine chamber 60 during rundown of the turbine 50. When turbine drive air is supplied to the handpiece through operation of a handpiece controller/rheostat (not shown; usually a foot pedal) the valve sleeve 61 is moved by the air pressure against the force of the spring 66 from the closed position shown in FIG. 6 to the open position shown in FIG. 5. In the open position, the valve sleeve 61 does not obstruct the turbine drive air supply conduit 62, the turbine air exhaust conduit 64 and the chip water/air supply conduit 63. As soon as the drive air supply is stopped, the biasing spring 66 moves the valve sleeve 61 back to the closed position in which it again blocks the turbine drive air supply conduit 62, the turbine air exhaust conduit 64 and the chip water/air supply conduit 63. This completely entraps the air found in the turbine chamber 60. As a result no vacuum can be created in the turbine chamber 60 and the turbine comes to a substantially instantaneous stop due to turbulence created in the chamber. It is important to

note that the valve sleeve 61 is constructed to not affect the supply of bearing air if an air bearing is used. This ensures continuous operation readiness for the air bearing, irrespective of the operational state of the turbine, which prevents damage to the air bearing caused by lack of bearing air supply during rundown of the turbine. In the preferred method of operating a handpiece in accordance with the present invention, the bearing air supply activation is coupled with the handpiece cradle (not shown) in such a way that bearing air is supplied to the handpiece for the whole time the handpiece is off the cradle.

Neck Portion Ergonomics

The shape of the handpiece neck portion has been redesigned in the handpiece of the invention to provide additional tooth clearance and better field of vision clearance. The neck portion of conventional handpieces is designed to provide a certain amount of tooth clearance. This is achieved by bending the forward end 17 of the neck portion 14 adjacent the head 16 away from the longitudinal axis of the handle 11 at a fixed angle of deflection. However, since the upwardly bent portion of the neck 14 is substantially straight, maximum tooth clearance is only achieved immediately behind the head portion 16. Furthermore, the maximum tooth clearance is limited by the length of the burr 80, since for ergonomic reasons the tip of the burr 80 must align with the longitudinal axis of the handpiece. This is required so that the angle of attack of the burr 80 on the tooth surface can be changed without movement of the burr tip by simply rotating the handle portion about the longitudinal axis of the handpiece.

Additional clearance and a better field of vision is now achieved in the preferred embodiment of a handpiece in accordance with the invention (see FIGs. 7 – 9) in that the forward part 17 of the neck portion 14 has two different bend angles. The bent portion 18 includes a first portion 19 adjacent the handle 11 which is bent away from the longitudinal axis of the handpiece at a much larger angle than in the prior art. The bent portion 18 further includes a second portion 19a which is bent in the opposite direction back towards the longitudinal axis and therefore encloses an angle with the axis which is much smaller than that of the first portion 19. This construction provides a larger area of clearance between the

bent portion 18 and the axis than in prior art designs. At the same time, it is ensured that the tip of the burr is still aligned with the longitudinal axis. This alignment allows the dentist to adjust the angle of the burr relative to the tooth of a patient without changing the hand support position. Adjustment of the burr angle is achieved simply by rolling the handpiece between the fingers, similar to a pen. The alignment of the burr with the handpiece axis prevents lateral displacement of the burr relative to the tooth as long as the handpiece is rotated about the longitudinal axis of the handle.

It is another significant feature of the swivel connector that the fiberoptic line is insulated from the exhaust air and therefore shielded from the deleterious effects of debris and lubricant leading to premature failure of the fiberoptics in prior art handpieces.

Swivel Connector

As mentioned above, conventional handpiece designs include swivel connectors for connection of the handpiece to the umbilical cord and preventing twisting and kinking of the umbilical cord. The weight of the umbilical cord places a strain on the dentist's wrist. This is aggravated by the relatively stiff umbilical cord extending from the rear of the handpiece, which acts as a lever. That problem has now been addressed in the preferred embodiment of a handpiece in accordance with the invention (see FIGs.8, 10, 11) in that the swivel connector is angled. Providing an angled swivel connection ensures that the umbilical cord always hangs more or less straight down from the handpiece so that the lever effect is overcome and the strain on the wrist significantly reduced. In the preferred embodiment shown in FIG. 11, the connector is constructed as a swivel connector 100 having an angled body 101 with a quick connect coupling arrangement at each end. The first quick cocnnect coupling 102 is designed to provide a rotatable swivel connection to the handpiece coaxial with the longitudinal axis of the handpiece, while the second quick connect coupling 103 provides a rotatable swivel connection of the connector body 101 to the umbilical cord (not shown). The angled connector can also be constructed as a retrofit connector for insertion in conventional swivel connection arrangements between the umbilical cord and the connector end of conventional handpieces. It will be readily apparent to the person skilled in the art that many different types

of swivel connection structures can be used to achieve the rotatable connection between the connector body 101 and the handpiece, such as screw-on, snap-on or quick connect (bayonet) type connections commonly used in the art. Consequently, a discussion of the detailed construction of the swivel connection is not required, since the art skilled person will be able to choose one of the known swivel type connections for multiple conduits. In principle, any the prior art connecting structure allowing a sealed rotatable connection for multiple rigid pressurized conduits can be used.

In the preferred embodiment of this invention, the swivel connector body 101 is directly fixed to the end of the umbilical cord and only has one swivel arrangement for connection with the handpiece (see FIG. 10). The connector body 101 also has a fiberoptic conduit extension 104, which isolates the fiberoptic line 105 from the turbine drive air, chip air/water and air exhaust conduits. This prevents contamination by oils (lubrication fluid for turbine and bearings) and fluids in supply lines, thereby maintaining the fiberoptic performance over a long service period.

The above-described embodiments of the present invention are intended to be examples only. Alterations, modifications and variations may be effected to the particular embodiments by those of skill in the art without departing from the scope of the invention, which is defined solely by the claims appended hereto.

What is claimed is:

1. A medical or dental handpiece for rotatably supporting a high speed rotating tool, comprising
a handle portion for gripping of the handpiece by a user; and
a head portion for supporting the tool for rotation about an axis of rotation, the head portion housing a tool mount or chuck for releasably holding the tool, a pair of axially spaced apart air bearings for supporting the chuck for rotation about the axis of rotation; and a turbine for rotating the chuck.

2. The handpiece of claim 1, wherein each air bearing includes a bearing cup of substantially semi-circular shape and a bearing body of complementary shape, the bearing body being shaped and constructed to closely fit into the bearing cup for generation of an intermediate bearing gap, the bearing gap having an even width throughout.

3. The handpiece of claim 2, wherein the bearing body and bearing cup are shaped and constructed to define an intermediate bearing gap of constant dimensions and a maximum width of 0.5mm.

4. A medical or dental handpiece for rotatably supporting a high speed rotating tool, comprising
a handle portion for gripping of the handpiece by a user; and
a head portion for supporting the tool for rotation about an axis of rotation, the head portion including a rotatable tool mount or chuck for releasably holding the tool, a turbine chamber for housing an air turbine for rotating the chuck, means for rotatably supporting the chuck and turbine in the head for rotation about the axis of rotation, and an annular air supply chamber extending about the axis of rotation for supplying drive air to the air turbine, the air supply chamber including means for directing drive air

into the turbine chamber onto the turbine in a direction radially inward toward the axis of rotation.

5. The handpiece of claim 4, wherein the head further includes a Venturi passage for speeding up the drive air redirected into the turbine chamber from the annular chamber, the means for directing drive air being positioned in the Venturi passage.

6. A dental handpiece, comprising
a handle for gripping by a user, a drive head attached to the handle for rotatably supporting a dental tool, an air driven turbine housed in the drive head for rotating the dental tool, and a swivel connector for rotatably connecting the handle to an elongated supply line including at least one conduit for supplying pressurized turbine drive air, the connector having an angled connector body for connecting the handle and the supply line at an angle of less than 180°.

FIG 1

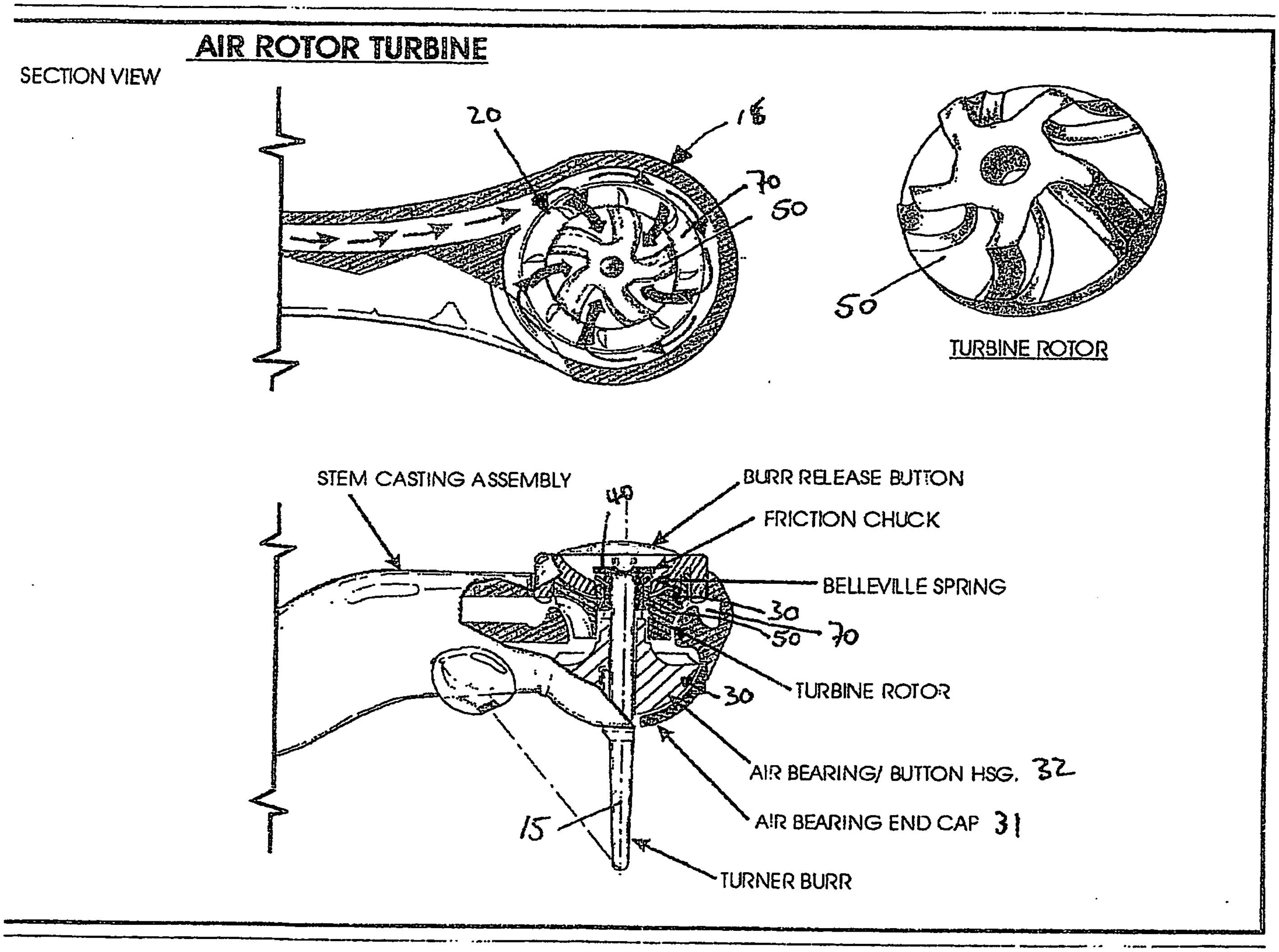

AIR ROTOR TURBINE
SECTION VIEW
20
18
70
50
50
TURBINE ROTOR
STEM CASTING ASSEMBLY
40
BURR RELEASE BUTTON
FRICTION CHUCK
BELLEVILLE SPRING
30
50
70
TURBINE ROTOR
30
AIR BEARING/ BUTTON HSG. 32
AIR BEARING END CAP 31
15
TURNER BURR

FIG 2

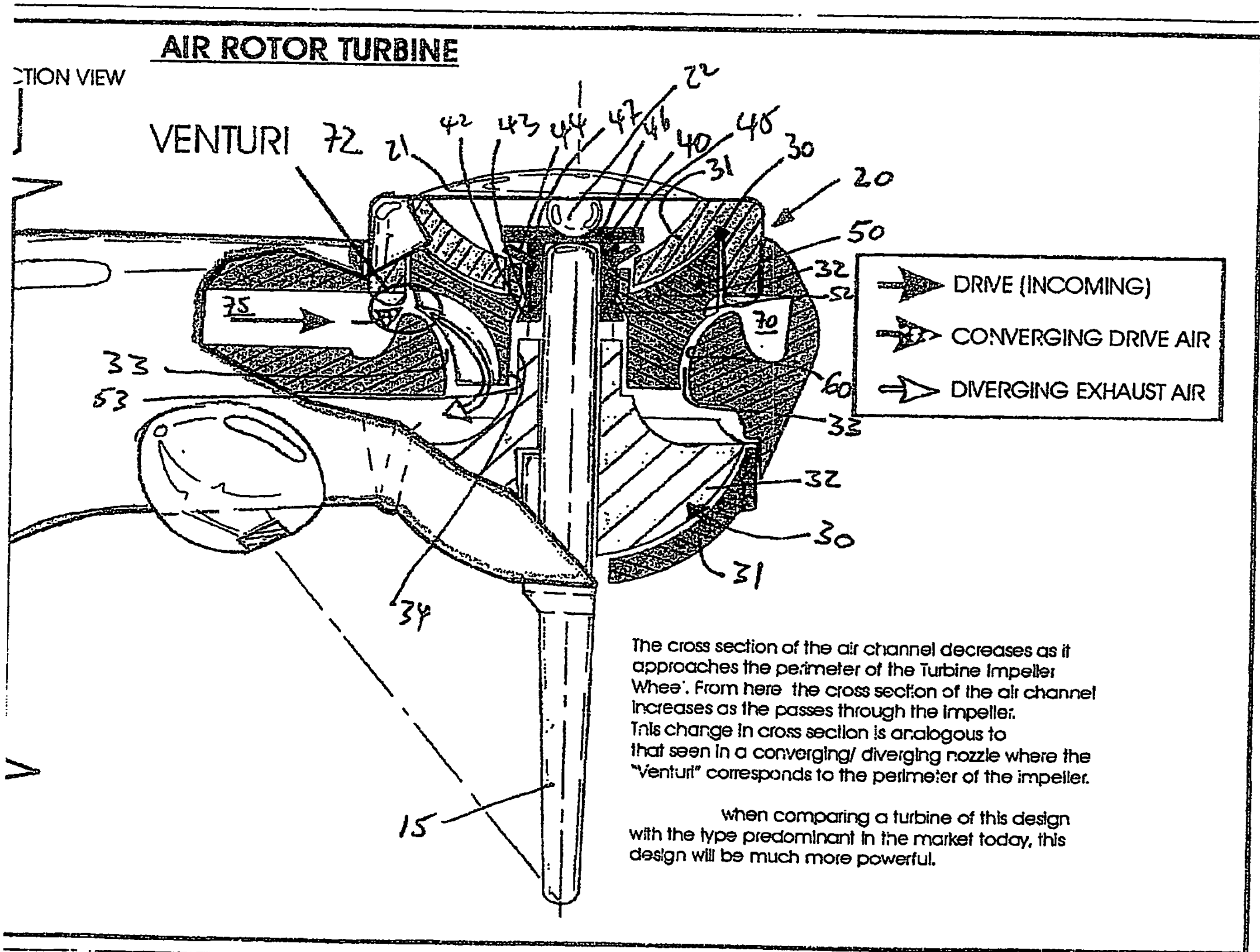

AIR ROTOR TURBINE
TION VIEW
VENTURI 72
21
42
43
44
47
46
40
22
48
31
30
20
50
32
52
70
75
33
53
60
33
32
30
31
34
15
DRIVE (INCOMING)
CONVERGING DRIVE AIR
DIVERGING EXHAUST AIR
The cross section of the air channel decreases as it approaches the perimeter of the Turbine Impeller Wheel. From here the cross section of the air channel increases as the passes through the impeller.
This change in cross section is analogous to that seen in a converging/ diverging nozzle where the "Venturi" corresponds to the perimeter of the impeller.
when comparing a turbine of this design with the type predominant in the market today, this design will be much more powerful.

FIG 3

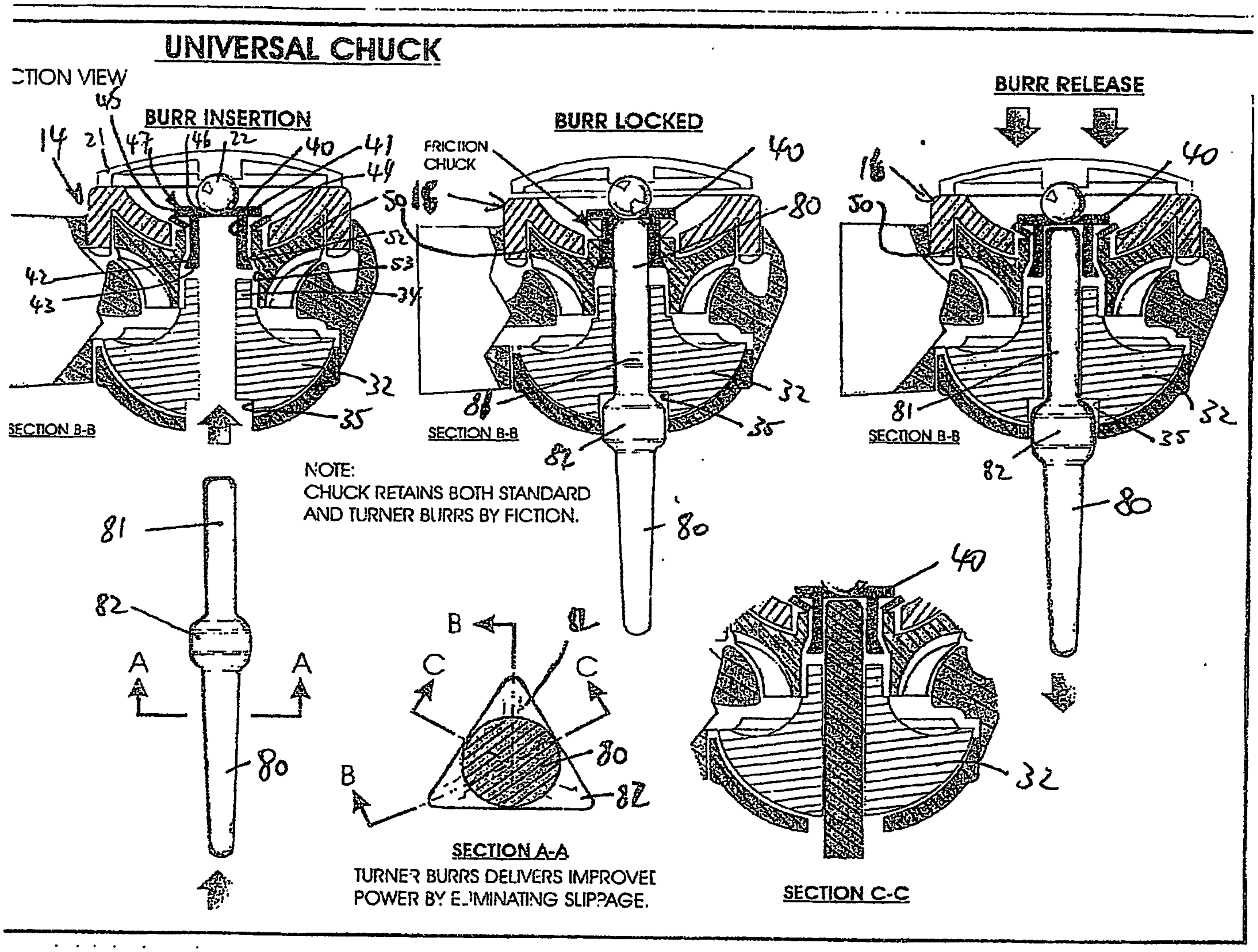
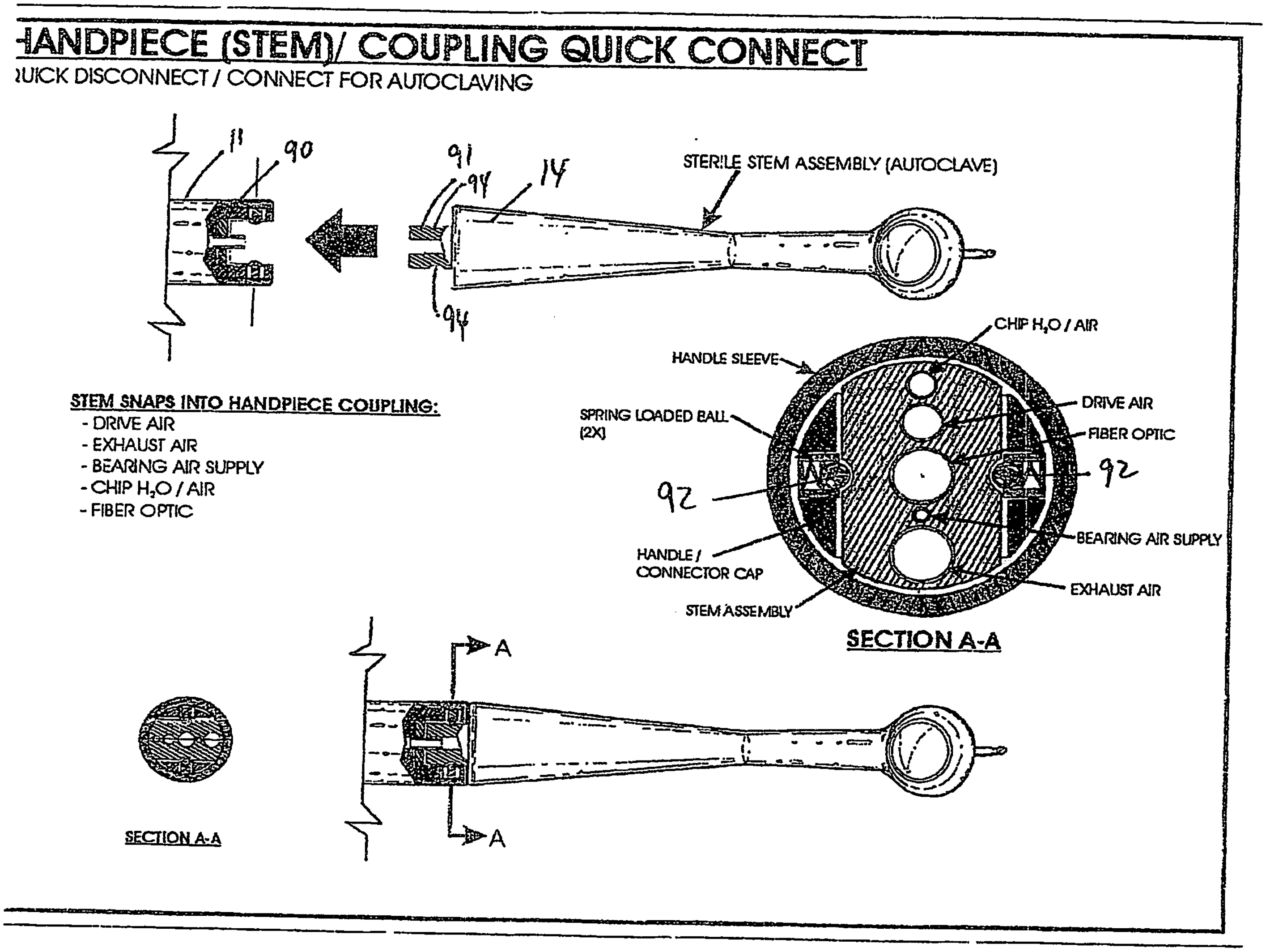
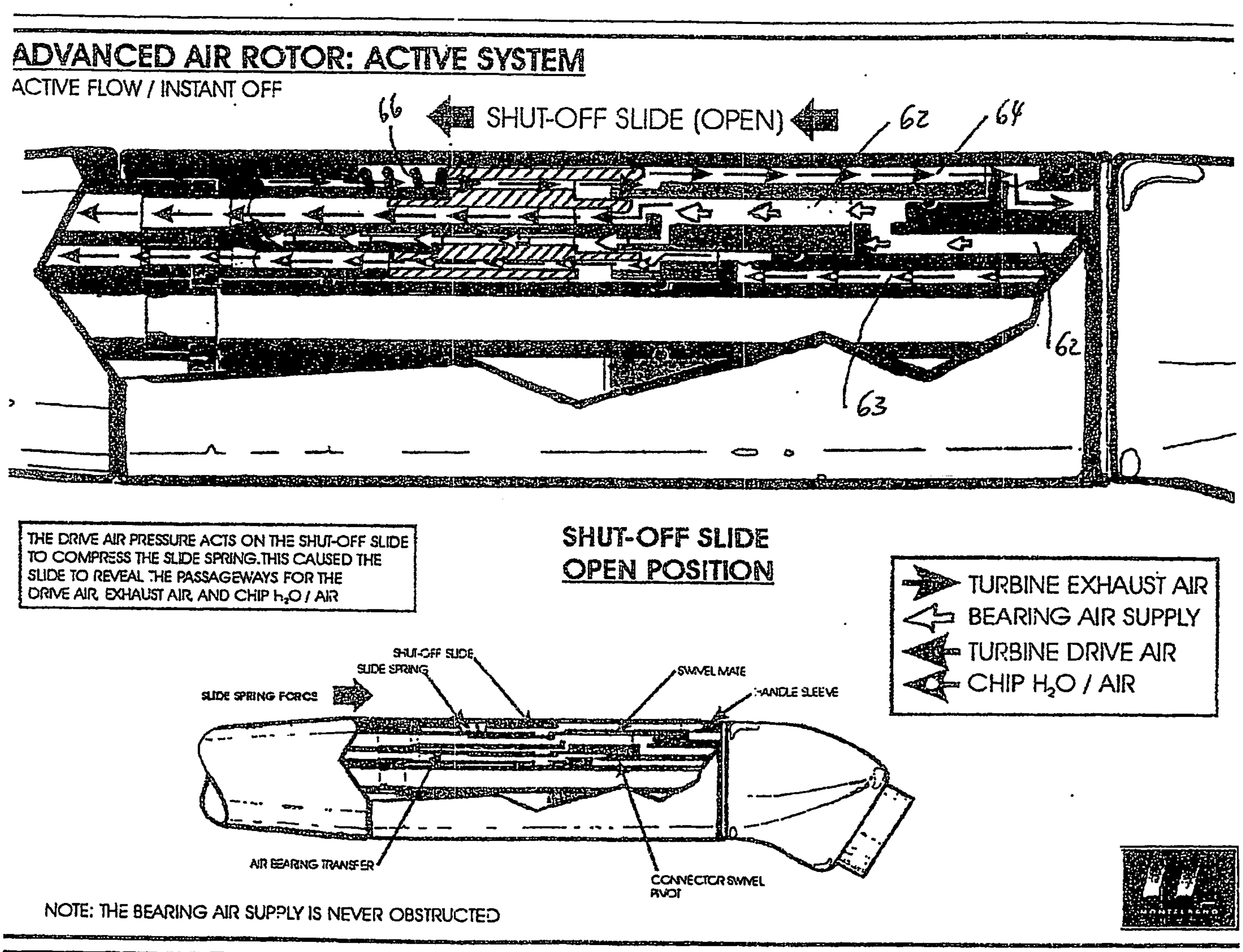

UNIVERSAL CHUCK
CTION VIEW
BURR INSERTION
BURR LOCKED
BURR RELEASE
FRICTION CHUCK
SECTION B-B
SECTION B-B
SECTION B-B
NOTE:
CHUCK RETAINS BOTH STANDARD AND TURNER BURRS BY FICTION.
SECTION A-A
TURNER BURRS DELIVERS IMPROVEI POWER BY ELIMINATING SLIPPAGE.
SECTION C-C
14
21
46
47
22
40
41
44
50
16
52
53
42
43
34
32
35
81
82
80
A
B
C

FIG 4



HANDPIECE (STEM)/ COUPLING QUICK CONNECT
UICK DISCONNECT / CONNECT FOR AUTOCLAVING
11
90
91
94
14
94
STERILE STEM ASSEMBLY (AUTOCLAVE)
CHIP H2O / AIR
HANDLE SLEEVE
DRIVE AIR
SPRING LOADED BALL (2X)
FIBER OPTIC
92
92
BEARING AIR SUPPLY
HANDLE / CONNECTOR CAP
EXHAUST AIR
STEM ASSEMBLY
SECTION A-A
STEM SNAPS INTO HANDPIECE COUPLING:
- DRIVE AIR
- EXHAUST AIR
- BEARING AIR SUPPLY
- CHIP H2O / AIR
- FIBER OPTIC
A
A
SECTION A-A

FIG 5

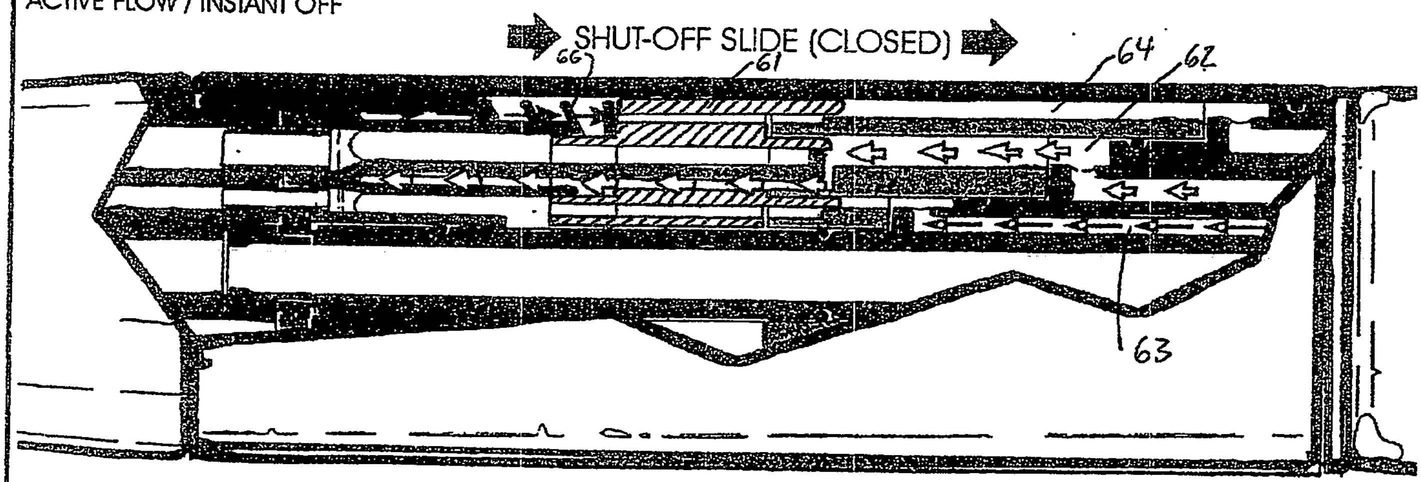

ADVANCED AIR ROTOR: ACTIVE SYSTEM
ACTIVE FLOW / INSTANT OFF
66
SHUT-OFF SLIDE (OPEN)
62
64
62
63
THE DRIVE AIR PRESSURE ACTS ON THE SHUT-OFF SLIDE TO COMPRESS THE SLIDE SPRING.THIS CAUSED THE SLIDE TO REVEAL THE PASSAGEWAYS FOR THE DRIVE AIR, EXHAUST AIR AND CHIP H_2O / AIR
SHUT-OFF SLIDE OPEN POSITION
TURBINE EXHAUST AIR
BEARING AIR SUPPLY
TURBINE DRIVE AIR
CHIP H_2O / AIR
SHUT-OFF SLIDE
SLIDE SPRING
SLIDE SPRING FORCE
SWIVEL MATE
HANDLE SLEEVE
AIR BEARING TRANSFER
CONNECTOR SWIVEL PIVOT
NOTE: THE BEARING AIR SUPPLY IS NEVER OBSTRUCTED

CA 02414908 2002-12-20

FIG 6

ADVANCED AIR ROTOR: ACTIVE SYSTEM

ACTIVE FLOW / INSTANT OFF



SHUT-OFF SLIDE
CLOSED (OFF) POSITION

- WHEN DOCTOR RELEASES FOOT PEDAL, AIR DRIVE PRESSURE CEASES AND THE SLIDE SPRING TRANSLATES THE SHUT-OFF SLIDE INTO THE CLOSED POSITION, CLOSING OFF TURBINE EXHAUST AIR, TURBINE DRIVE AIR, AND CHIP H_2O/ AIR.
- SINCE THE TURBINE DRIVE AND TURBINE EXHAUST AIR ARE INSTANTLY TURNED OFF THE TURBINE ROTOR MOMENTUM DISSIPATES IN THE TURBULENCE WITHIN THE TRAPPED AIR.
- ADDITIONALLY, THE CHIP H_2O / AIR IS INSTANTLY TURNED OFF, CLOSE TO IT'S POINT OF DISPENSE.

NOTE: THE BEARING AIR SUPPLY IS NEVER OBSTRUCTED. ADDITIONALLY, THIS PASSAGE WAY IS KEPT SMALL SO THAT IT PROVIDES THE ABILITY TO ACHIEVE AIR PRESSURE DIFFERENTIALS TO ALLOW THE SHUT-OFF SLIDE TO COMPRESS THE SPRING WHEN AIR IS APPLIED.

TURBINE EXHAUST AIR
BEARING AIR SUPPLY
TURBINE DRIVE AIR
CHIP H_2O / AIR

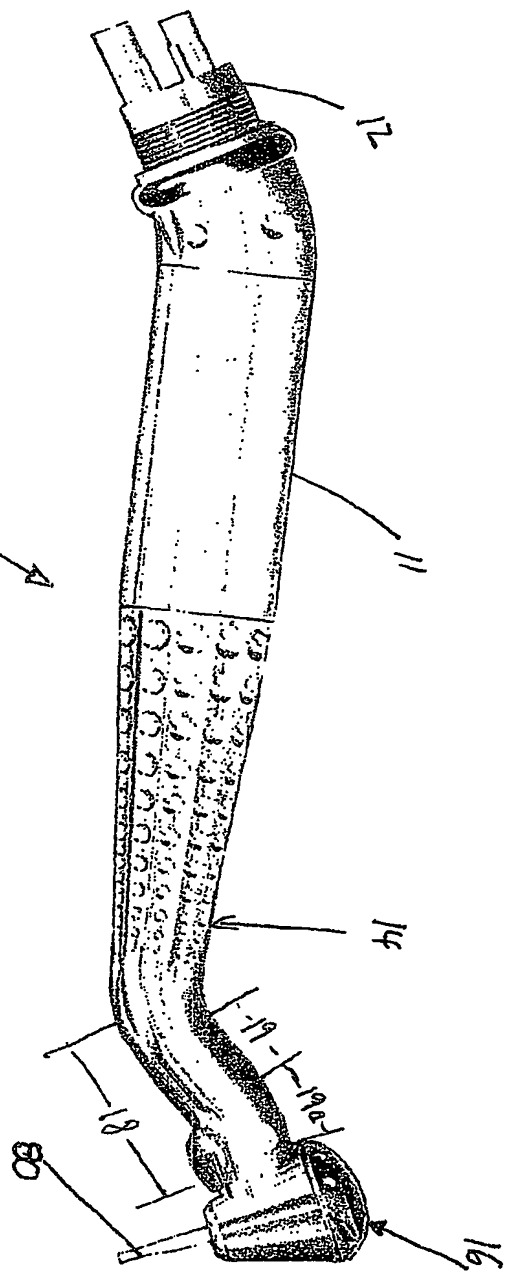
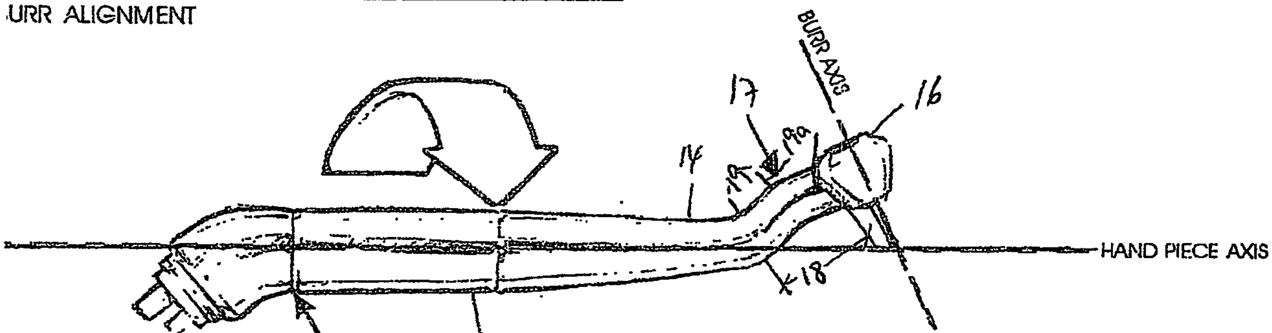


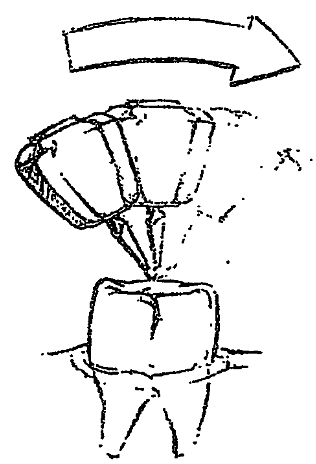
FIG 7

FIG 8

\DVANCED AIR ROTOR ERGONOMICS

·URR ALIGNMENT



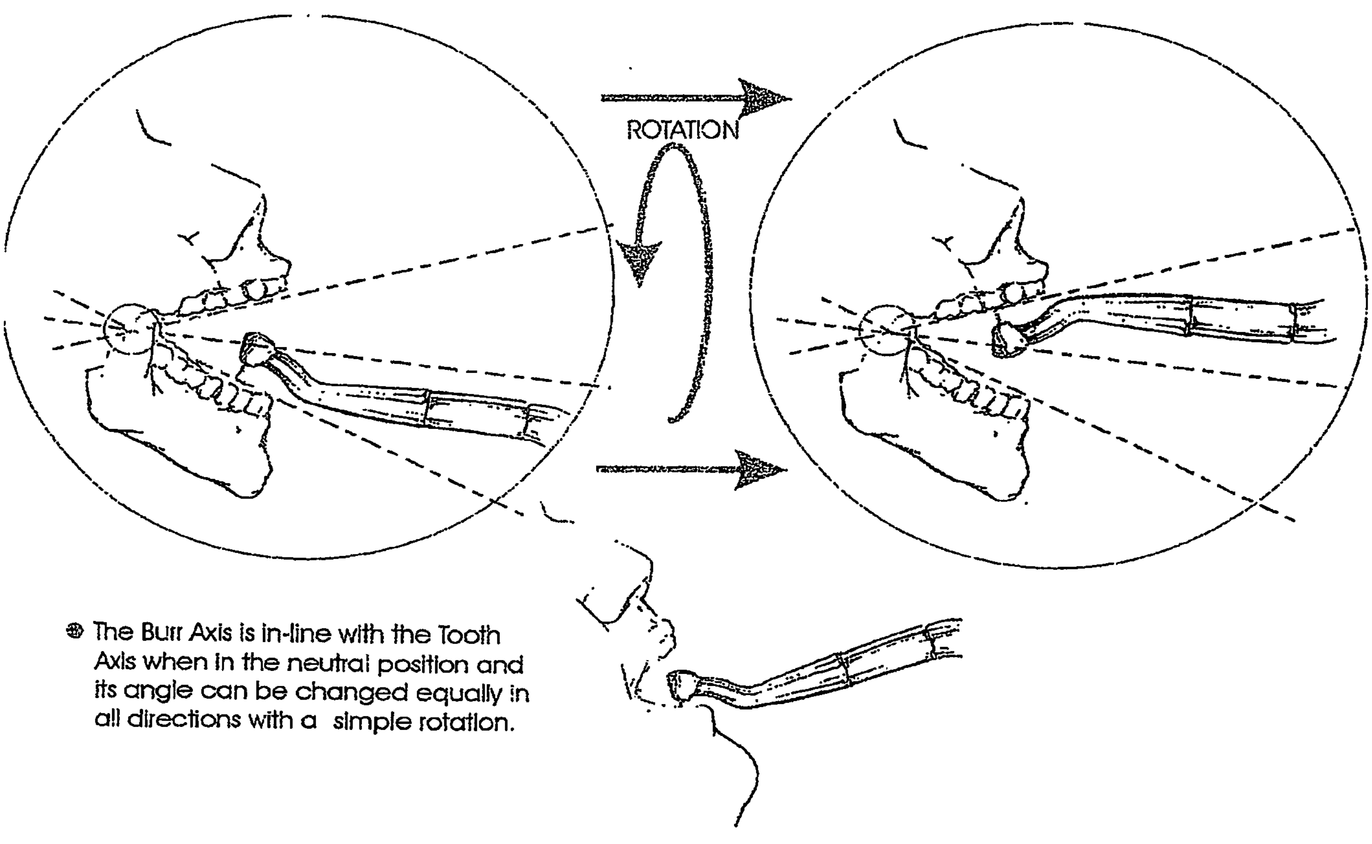


- The Main Handpiece axis and the tip of the Burr are collinear; rotating the handle changes the bur angle without disturbing the burr tip location.
- Doctors hand bracing can remain set in position while rotating the hand piece for burr angle adjustment.

FIG 9

)VANCED AIR ROTOR ERGONOMICS

ꝛR ALIGNMENT



- The Burr Axis is in-line with the Tooth Axis when in the neutral position and its angle can be changed equally in all directions with a simple rotation.

FIG 10

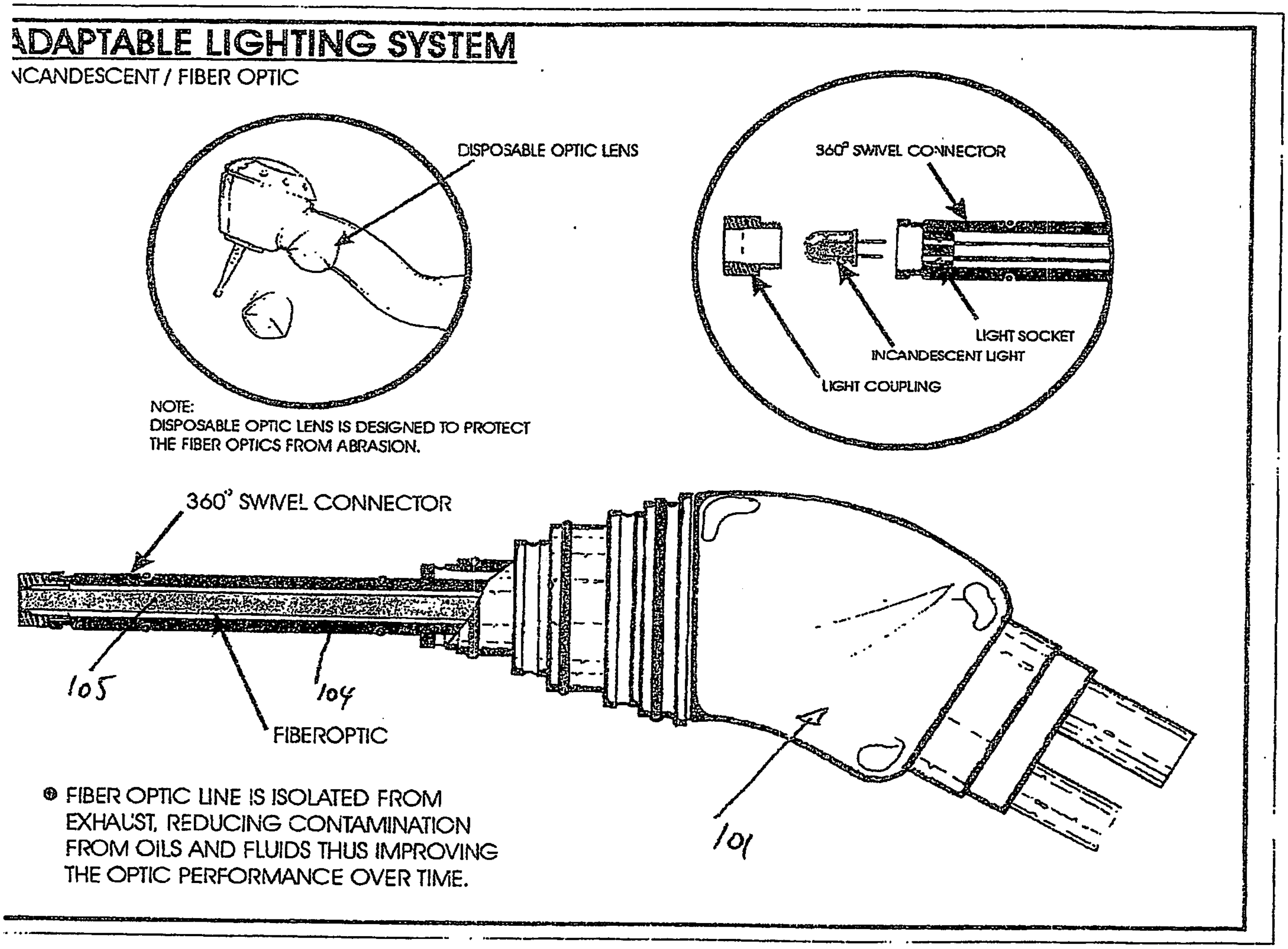
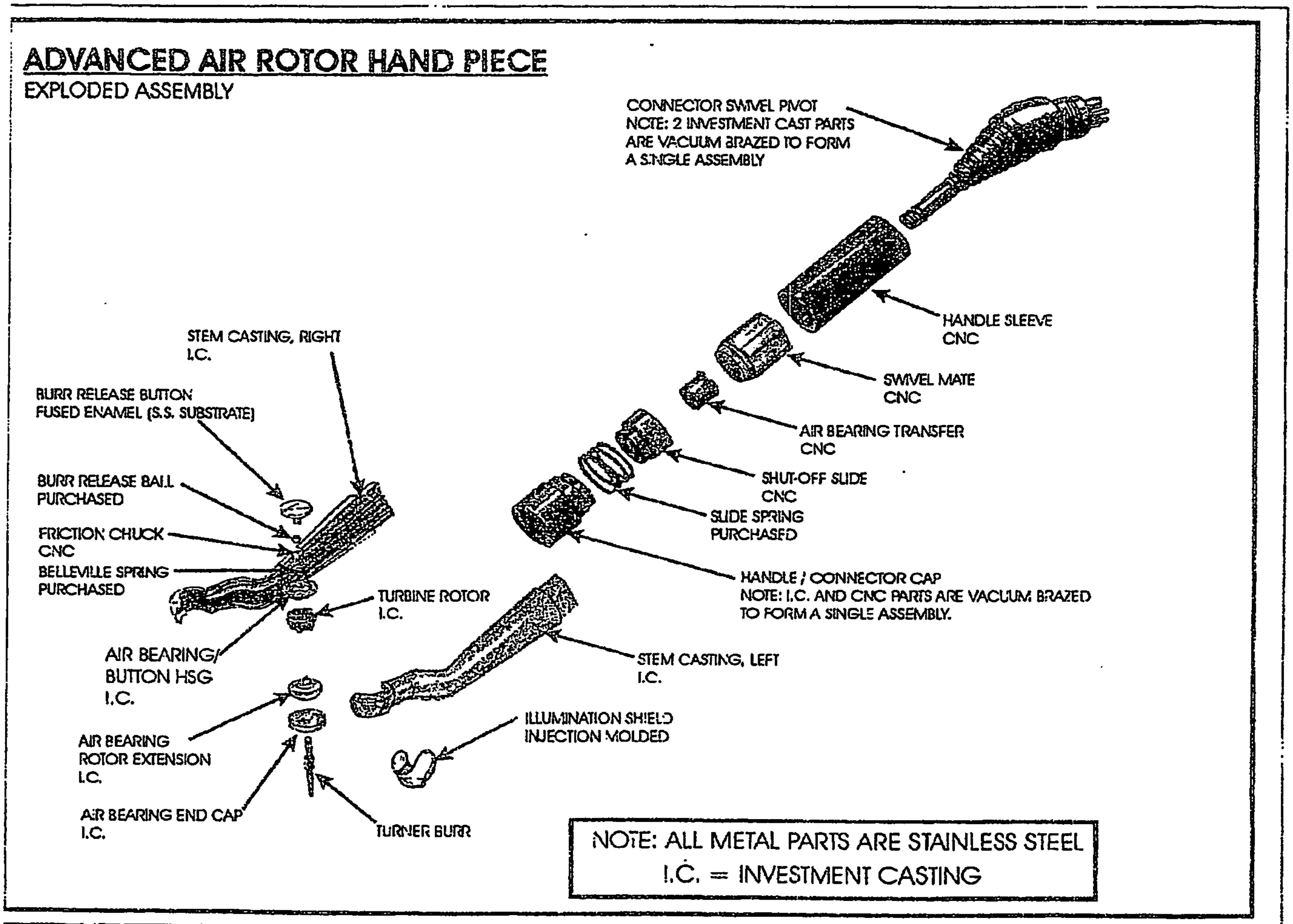

ADAPTABLE LIGHTING SYSTEM
INCANDESCENT / FIBER OPTIC
DISPOSABLE OPTIC LENS
NOTE:
DISPOSABLE OPTIC LENS IS DESIGNED TO PROTECT
THE FIBER OPTICS FROM ABRASION.
360° SWIVEL CONNECTOR
LIGHT SOCKET
INCANDESCENT LIGHT
LIGHT COUPLING
360° SWIVEL CONNECTOR
105
104
FIBEROPTIC
101
FIBER OPTIC LINE IS ISOLATED FROM
EXHAUST, REDUCING CONTAMINATION
FROM OILS AND FLUIDS THUS IMPROVING
THE OPTIC PERFORMANCE OVER TIME.

FIG 11



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